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SPONDYLOLISTHESIS, WITH DESCRIPTION OF A CASE.

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THE name spondylolisthesis (σπόνδυλος, a vertebra, and ὀλισθήσις, a gliding) refers to a forward subluxation of the body of one of the lower lumbar vertebræ, with the exception of one recorded case where the upper part of the sacrum was displaced forward. This displacement has ordinarily been described as a dislocation; in most instances it hardly reaches a greater degree than may be described by the name subluxation. Even this name is incorrect anatomically. This is because the body of the vertebra is chiefly affected, while the laminæ and spinous process remain practically in place.

The condition has attracted attention chiefly from the obstetrical point of view, on account of the secondary pelvic changes produced, and surgical literature contains next to nothing about it. Fr. Neugebauer,¹ of Warsaw, has so thoroughly investigated and elaborated the subject that whoever strives to elucidate it from any point of view must do so largely by quotations from his extensive writings.

In 1854, when this condition was recognized and named by Killian,² there were described only four known anatomical specimens. In 1890, when Neugebauer's treatise was written, there were one hundred and one clinical and anatomical observations. Blake,³ Gibney,⁴ and Lombard⁵ contributed the only recorded American observations. Between the publication of Neugebauer's classic in 1892, which was written in 1890, and to-day there have been reported, so far as I could find, twenty-four more cases (two in men).

The later cases add little to the surgical interest, excepting those

presented by
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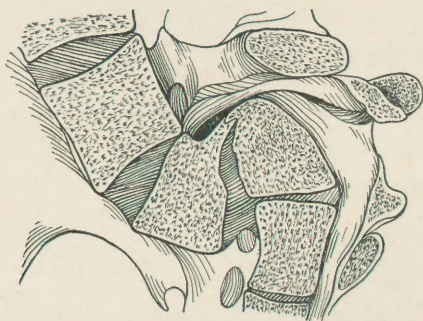
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of Dollinger, where the deformity occurred in a child of three years, as the result of a fall; the case of Lane, reported in 1893, where laminectomy was performed for the relief of pressure symptoms and the lamina of the fifth lumbar vertebra removed; the preparations by Chiari, which are of pathological interest; and the case described by Braun von Fernwald, which, with his paper, is noteworthy for its completeness and pathological interest (see Reference to Recent Literature, p. 15). So far as could be learned, no American case has been added to those of Neugebauer's list, except the one here described.

Lane* dissents from Neugebauer that the affection is one of great rarity, believing that it occurs commonly among people who perform heavy manual labor, and he goes so far as to state that "looking at the changes which the skeletons of laborers undergo, I found that in fully developed coal-heavers spondylolisthesis is the normal condition, and that in other occupations a similar displacement existed." On the whole, however, the tendency of opinion seemed to be with Neugebauer, that the affection is a rare one, and that the pathological scheme proposed by him is, on the whole, a correct one.

FIG. 1.



Pelvis of Moscow (median section). Instance of extreme forward displacement of fifth lumbar vertebra. (NEUGEBAUER.)

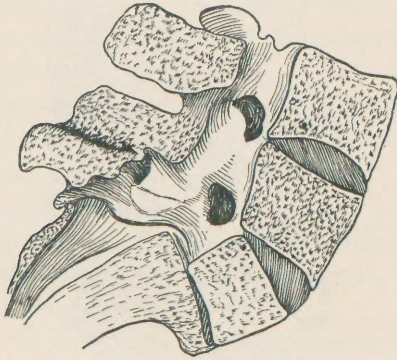
Pathology. The pathological condition is fairly constant, the degree and location varying within certain limits. The essential part of the condition seems to be the slipping forward of one of the lower lumbar vertebral bodies, while the vertebral arches

* Lancet, 1893, xxix. p. 991.

remain practically in place. This implies, of course an increase in the distance between the body and the spinous process of such a vertebra, and the cause of this elongation or division of the vertebral arch is the subject of the discussion. That this condition exists is established beyond any doubt by the specimens in the museums of Europe.

The commonest form of the displacement is subluxation of the fifth lumbar vertebra in relation to the sacrum (thirty in forty-two specimens). The displacement of the fourth lumbar vertebra in relation to the fifth is next in frequency (twelve in forty-two specimens). The displacement forward of the first sacral vertebra in relation to the rest of the sacrum* has been recorded once only

FIG. 2.



Small pelvis of Prague (median section). Instance of slight forward displacement of fifth lumbar vertebra. (NEUGEBAUER.)

(H. von Meyer, Zurich specimen). This specimen has been spoken of as pseudo-spondylolisthesis, but the distinction seems hardly worth maintaining.

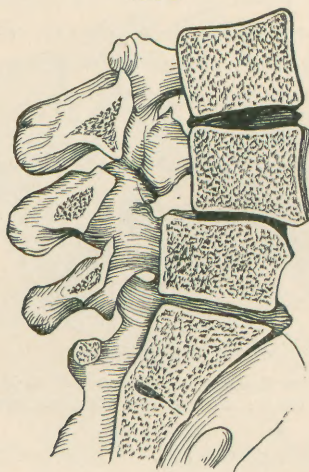
The displacement may be slight and the fifth lumbar vertebra project only slightly ahead of the sacrum† (Prague specimen) or it may be extreme and the fifth lumbar vertebra may be rotated through ninety degrees, and its lower surface in this case will lie against the front of the upper part of the sacrum (*e. g.*, Halle specimen, Moscow pelvis, see Fig. 1). Secondary changes occur in the severer cases. The displaced vertebra may become condensed

* Berlin specimen, Virchow.

† Berlin specimen, Virchow.

and wedge-shaped, and pressure effects in modifying the shape of bones are also noticed in the upper part of the sacrum. Exostoses may develop about the joints of the displaced vertebræ, apparently elongating them, and the intervertebral joints may be obliterated or the fibro-cartilage may be replaced by an arthrodial joint. The intervertebral disks in the region of the deformity are changed in shape by the pressure, and at times some modification of the articular processes may result from the pressure, but these changes are not uniform. The bony arch connecting the vertebral bodies and the laminæ may, as I understand it from the literature, be either thinned and intact, or it may be separated entirely. This may be a unilateral or bilateral condition.

FIG. 3.



■ Breslau specimen. Instance of slight forward displacement of the fourth lumbar vertebra. (NEUGEBAUER.)

The pathological condition may be better understood by a glance at the figures than by any discussion, however lengthy. The amount of displacement obviously varies within very wide limits, and with it the clinical phenomena must vary also.

So marked a change in this region of the vertebral column, where the curve is so sharp, results, of course, in a marked disturbance of equilibrium, and the symptoms vary as the direct outcome of the mechanical condition. The posterior superior iliac spines are

more widely separated than normal in severer cases and the inclination of the pelvis is diminished (Neugebauer).

The essential point, it may be repeated, in spondylolisthesis is not so much the subluxation of the body of the vertebra as the antero-posterior elongation of the body of the lumbar vertebra. This exists always, and is apparently the pathological condition peculiar to this situation and this condition.

In comment on this it should be remembered that each vertebra develops from three centres of ossification, one for the body and one for each lamina and its processes. The vertebral arch forms during the first year by the joining of the two posterior centres of ossification, but this is not joined to the centre of ossification of the vertebral body until the third year (Gray).

The causes of separation of the anterior and posterior parts of the lumbar vertebræ are classified by Neugebauer, and generally accepted to be as follows :

I. Separation on one or both sides between the body and the laminae of the vertebra.

(a) Due to a defect in development.

(b) Due to fracture.

II. Primary disease of the sacro-vertebral articulation.

III. Vertebral deformity, due to superimposed weight and bony changes resulting from pressure.

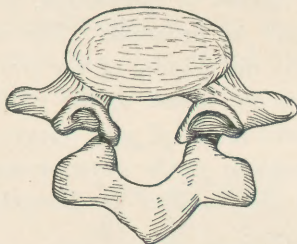
Each of these divisions will be briefly considered in turn.

I. (a) *The Separation of the Vertebral Arch due to Congenital Defect.* Deficient union or absence of union between the vertebral laminae and the bodies is recognized under the formidable names of spondylolysis or spondyloschisis (Lambl⁶). Such lack of union, or imperfection of union, might, under the circumstances of injury or excessive weight-bearing, predispose to spondylolisthesis. That such congenital deficiency of vertebral union is not excessively rare is shown by the statement of Neugebauer that Langer estimates this defect as occurring in 10 per cent. of skeletons, and Jendrzych-inskiz in 5 per cent. Neugebauer has found two hundred and forty anatomical specimens in European museums illustrating the condition, and a good deal has been written on the subject.*

* Broca : Bull. de la Soc. d'anat. de Paris, 1884, p. 448. Treub : Nouv. arch. d'obst. et de gyn., 1889, iv. 410, with figures. Turner : Report on Human Skeletons. Challenger's Reports, xvi., 1886.

I. (b) *Separation of the Vertebral Arch due to Fracture.* Fracture between the bodies and the laminae of the vertebræ may occur in the lumbar vertebræ, and at first all cases of spondylolysis were described as traumatic (Howship, Bell, Otto, Mayer, etc.). Now, after cases of separation of real congenital origin have been set apart, clearly traumatic cases of fracture in this locality are also to be recognized. There are such specimens in many European

FIG. 4.



Specimen from the museum of K lliker at Wurzburg, showing double defect in the vertebral arch. (NEUGEBAUER.)

museums. (Royal College of Surgeons, No. 433, three lumbar vertebræ. St. Thomas' Hospital, E. 27, fifth lumbar vertebra. Museum of Friedburg, N. O. II., two second lumbar vertebræ. Anatomical Museum at St. Petersburg, fracture of the fifth lumbar vertebra with callus, and others.)

Fractures located here may occur from indirect violence, by *contre-coup*, as in falls, and from hyperflexion of the trunk, as at the lower lumbar region the movable vertebral column changes to the rigid pelvis, and the mechanism of such fractures can be studied in Krukenburg,⁷ Meyer,⁸ Strasser,⁹ Winckel,¹⁰ and Czaussouw.¹¹ Apparently, from the case recorded in this paper such fractures also result from direct violence.

II. *Disease of the Sacro-vertebral Articulation.* Strasser⁹ has advanced the theory that inflammation of the lumbo-sacral articulation may be the cause of the deformity. In addition to the case reported by him, a specimen in the museum of Czaussouw, at Warsaw, supports the theory that such arthritis (probably of traumatic origin) may be the cause of spondylolisthesis, not only by its own effect, but by causing secondary changes in the arches and their connection with the bodies of the vertebræ.

III. *Bony changes the Result of Pressure.* W. A. Lane¹² has advanced the theory that excessive weight-bearing and hard labor may be the cause of spondylolisthesis, and, as the result of his demonstration that continuous severe bony pressure is able to cause bone atrophy and absorption, he finds the cause of the elongation of the vertebral arch and the wedge-shaped condition of the displaced vertebræ is a mechanical result of such long-continued or excessive pressure.

By its anatomical position the body of the fifth lumbar vertebræ is likely to be pushed forward, especially if imperfectly supported by the ligaments. The relation that this pressure bears to the tendency of pregnancy to increase and at times to cause spondylolisthesis is of interest inasmuch as the pelvic articulations are softened and vulnerable during pregnancy. Lane lays the greatest stress upon hard manual labor as the causative factor.

This theory undoubtedly bears upon all cases to some extent and explains others wholly. Within certain limits it meets with almost universal acceptance. It has been elaborated at length by Lane in various papers, and his opinion as to the frequency of spondylolisthesis has been already alluded to.

Chiari* advances as a cause the abnormal development of the lumbo-sacral-joint area, and bases this on a case where he found lengthening of the lower surface of the fifth lumbar vertebra (without lengthening of the arch), thus classing it as an abnormality of development.

The development of exostoses about the articular surfaces of the displaced vertebra has been already alluded to (specimen in Neugebauer's collection, figured in book, p. 6, Fig. 1).

Other theories as to etiology may be dismissed with a mere mention as being unsupported by pathological evidence, such as Lambl's theory† that the deformity is due to fœtal hydrorrhachis, etc., that spondylolisthesis is the result of inflammatory bone disease¹³ or softening of the joints.‡

* Zeitsch. f. Heilk., 1892.

† Lambl.: Cent. f. Gyn., 1881, xi. p. 25; xii. p. 28; 1885, xxiii. p. 356. Virchow's Archiv, 1857, xi. 2, 187.

‡ Bohn: Inaug. Diss., Berlin, 1892. A New Case of Spondylolisthesis, with Successful Delivery. Olshausen: (a) Mon. f. Geb. u. Gyn., 1861, Bd. xvii. p. 255. (b) Mon. f. Geb. u. Gyn., 1864, Bd. xviii. p. 190.

Causation. Spondylolisthesis is recorded as affecting women more frequently than men, and comparatively few male cases have been recorded.

It occurs almost always at puberty or in young adult life, and the majority of all cases, of whatever kind or degree, where any history is obtainable, give the account of a severe traumatism, occurring most often during childhood or near puberty. Falls from a distance, striking on the back, blows upon the lumbar region, or forced flexion of the spine, are the causes generally given. The deformity may follow immediately upon the accident, or it may develop in after years, just after puberty or during pregnancy. Other cases are to be accounted for only by frequency of pregnancy or by very hard work. Many cases are incompletely recorded, and in a few no assignable cause can be found.

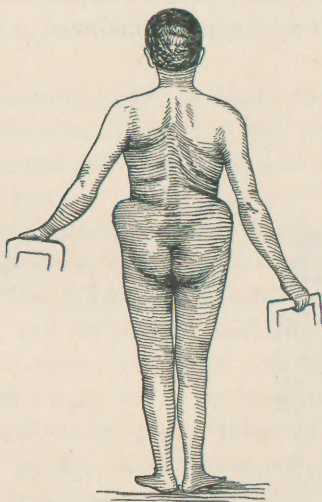
Symptoms. It is obvious on reading the literature on the subject that many cases must present trivial symptoms, for the spondylolisthesis has often been first detected in the autopsy room or upon the dissecting table, and by an inspection of the figures of the pathological specimens recorded it is evident that the degree of bony displacement varies so widely that the symptoms must needs range from a slight increase in the backward prominence of the iliac crests to a condition where the patient walks forward with a gait almost like a quadruped (see references).*

The symptoms by which the diagnosis must be made are as follows: A disturbance of equilibrium resulting in a faulty carriage, which is shown chiefly by a sharp increase in the lower lumbar curve in even the mildest cases. More exactly it seems to be a prominence of the iliac crests and buttocks in relation to the lumbar spine. There is no apparent falling away of one spinous process from another, for reasons that have been demonstrated in speaking of the pathology. The spine curves forward sharply from the sacrum, and this gives undue backward prominence to the crest of the ilium and the buttocks. The appearance at first glance is the same as that in cases of double congenital dislocation of the hip. Lateral deviation of the spine may be present, and is generally

* Paderborn case. Killian: *Comment. Anat. Obst. de Spondylolisthesis*, Bonn, 1853. Halle case. Olshausen: *Monatsschrift für Geburtshülfe und Gyn.*, 1861, xvii. 255; 1864, xxiii. p. 190.

indicative of a lesion more or less unilateral. Pathological examination has shown that spondylolithesis not infrequently exists only on one side; lateral deviation may, however (as in the case here reported), be only an indication of muscular irritation, similar to the lateral deviation in Pott's disease, and, as in that case, it may be temporary and disappear largely under treatment. With this lordosis goes a diminution of the obliquity of the pelvis, which

FIG. 5.



Case of spondylolithesis. (BREISKY.) Woman thirty years old.

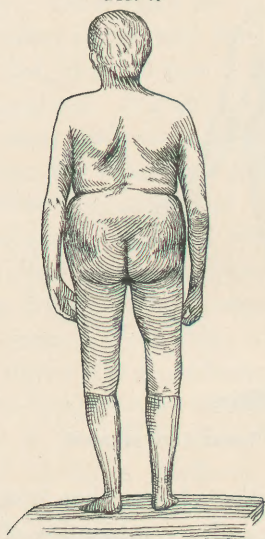
rotates on its transverse axis, and the pubis is higher than it should be normally, while the sacrum is lower. The combination of lordosis with diminished pelvic obliquity is said to be pathognomonic by Neugebauer. The rotation of the pelvis is an important factor in that it tightens the anterior ligaments of the hip, and thus tends to cause a flexed position of the thighs.

Vaginal examination shows, of course, a prominence high up on the posterior wall of the pelvis, and the obstetrical side of this aspect of the question has been elaborated with the greatest thoroughness and by the most careful measurements. The trunk is shortened in relation to the legs, on inspection, even in such mild cases as the one recorded, and the thorax tends to approach the

pelvis. In the severer cases the distance between the ensiform cartilage and the pubes is surprisingly diminished. In the severer cases lateral folds of the skin in the back or abdomen are likely to appear.

The gait in spondylolisthesis is said by Neugebauer to be modified in a characteristic way, and by tracings taken he has apparently demonstrated that the footprints resemble those of a normal woman at the end of her pregnancy. The footprints in severer cases show marked eversion of the feet; but what is more characteristic is that the prints of the right and left foot in progression lie more nearly ahead of each other than is normal, and a straight line passes

FIG. 6.



Case of spondylolisthesis. Woman thirty-six years old. Hard work, but no severe trauma. Rear view. (BRAUN VON FERNWALD.)

FIG. 7.



Side view of same case as Fig. 6. (BRAUN VON FERNWALD)

through the heel prints of both right and left foot, which is not the case in the normal foot. Braun von Fernwald, however, failed to confirm Neugebauer's observations in this regard, and the question still remains open, but it would seem that any abnormality of this sort must vary so much in proportion to the degree of pain and deformity that the diagnostic value must be slight.*

* Arch. für Gyn., 1896, p. 126.

Pain and stiffness, of course, follow the accident, and nervous disturbances of the legs and feet, varying from those of slight degree to complete paralysis, may be present. The affection is not, however, one characterized by excessive pain.

The chief signs by which diagnosis is to be made are evidently an increased lumbar lordosis occurring in connection with pregnancy or a fall; a disturbance of the relation in the spines of the lumbar vertebræ to the crests of the ilium; shortening of the trunk; a disturbance of equilibrium resulting from the distortion; generally some scoliosis, and often some inability to extend the legs fully.

The differential diagnosis must be made from Pott's disease, double congenital dislocation of the hip, and rickets. Pott's disease offers the greatest difficulty, and exclusion of it must be made on general diagnostic points.

In the case here recorded the gait and the general symptoms at first were strongly suggestive of lower lumbar Pott's disease, but this failed to explain the attitude, the shortening of the trunk, the flexion of the thighs, and the peculiar lordosis.

The absence of a knuckle or a rigid area in the upper spine, along with a deformity not accounted for by softening of the bodies of the lumbar vertebræ, would generally serve to make this clear. Such immediate and permanent improvement resulting from fixation as occurred here is not, as a rule, consistent with the existence of tuberculous diseases of the bodies of the lumbar vertebræ.

Double congenital dislocation of the hips is easily excluded by finding the trochanters on Nélaton's line and the history of the case, where it is obtainable.

Rickets must be recognized by its general diagnostic signs. In rickets the pelvic inclination is increased, and in any case so severe as to produce a very marked lordosis other characteristic signs must be found.

Treatment. So far as can be judged from the case here recorded, and from the few cases considered, from a surgical aspect the most successful treatment consists in fixation of the lower spine by a jacket or brace until the fracture, if such has occurred, has united and the products of the injury have been absorbed; or, if heavy weight-bearing has been the cause, until the stretched and weakened

tissues have resumed as normal a position as possible. This period must, of course, last for months, or in cases of great deformity it would seem as if a fixation support must be permanent. Generalizations from one case are of little value, but in the case recorded the greatest benefit was found at once from the application of a plaster jacket. Laminectomy, as demonstrated by the case of Mr. Lane, is an operation to be considered where symptoms of bony pressure are present for any length of time. He found, however, the greatest difficulty in removing the lamina, which was in this case somewhat displaced forward. On opening the spinal canal it was evident that bony pressure existed by the bulging of the compressed parts. In Gibney's case an unsuccessful attempt was made to reduce the deformity under ether.

[NOTE.—A complete index of literature previous to 1890 is to be found in Neugebauer's monograph, *Spondylolisthesis et Spondylizéme*, Paris, 1892, G. Steinheil, editeur.]

William C., eighteen years old, a young man at school, was referred to me on September 5, 1896, by Dr. J. E. Garland, of Gloucester. He had always been fairly well except as a baby, when he had been sickly, with no especial disease. Later he grew strong, and as a boy and young man was free from all disability, athletic, well developed, and of good physique. There was nothing unusual about his figure. He was straight and square, and able to do as much or more than other boys.

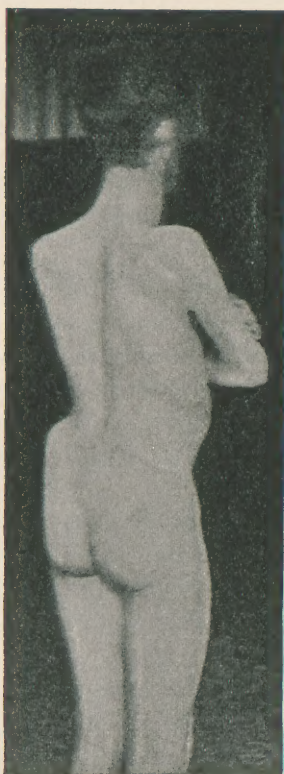
On April 3, 1896, he was helping about a stable and was leading a harnessed horse, which was attached to a heavy wagon; the horse took fright at something and became unmanageable; the young man lost his hold, the horse ran away, and both wheels of the wagon, weighing twenty-six hundred pounds, passed over his pelvis.

The patient suffered much pain; he found that he could not bear any weight on his feet, nor could he sit down. He was carried home, and, as I understand it, had no medical attendance. He had no passage of blood from the urethra or rectum, and was only confined in bed for a week or so. At the end of that time his family got him crutches, and he went around more or less, although he suffered a good deal of pain, mostly in his legs and a little in his back.

When he came to see me he walked very badly, bent forward, and leaned well over to the right. There was marked limitation of motion in the lumbar region of the spine, and when he lay on his back the knees could not be touched to the table.

On inspection he was found to be a well-developed young man, standing bent over forward and to the right. Movement in all directions was attended by much pain, and he looked somewhat worn and white from the long disability.

FIG. 8.



The knee reflexes were normal, and there was no disturbance of sensation in the feet or legs. The bladder and rectum were normal. His general aspect, so far as movement went, was that of a case of severe lumbar Pott's disease and psoas abscess.

What attracted my attention was the sharp prominence of the iliac bones backward, the very marked lordosis in the lumbar region, and the shortening of the trunk. The shape of the hips was strongly suggestive of double congenital hip dislocation, but the trochanters were on Nélaton's line.

It could easily be felt in examining the spine that between the sacrum and the lumbar spine there was a sharp difference, the lumbar spine being further forward than it should be and the upper part of the sacrum apparently being in the normal place.

The provisional diagnosis of spondylolisthesis was made, and, as it was evident that there was much pain in motion and that the vertebral articulations were in a state of much irritability, a plaster jacket was advised and was applied under suspension. On being let down on to his feet the patient stood better and experienced a feeling of relief.

He returned at intervals of two months for jackets, and in February, 1897, was given a laced jacket and told to remove it at night.

On April 22, 1897 (a year after the accident), he was again examined and was discharged from treatment, as all symptoms of irritation had disappeared. The lateral curvature, as can be seen from the picture, had almost entirely disappeared. The left crest of the ilium is a little more prominent than the other. The deformity of the lumbar spine remains, but is apparently less marked than before.

Lateral flexion of the trunk with the arms behind the head is not normal, but perhaps to within two-thirds of the normal limit.

In standing with knees straight he can bend over until the tips of his fingers are twenty inches from the floor. No motions are painful.

With the pelvis flexed and the arms behind the head right and left torsion of the trunk are about one-half of normal. He can lie on a table and touch both knees without arching the spine. The walk is not perceptibly bad with the clothes on, and there is absolutely no pain.

He is able to go without the jacket a good part of the day, and expressed himself as conscious of no disability from the accident.

The case is reported at some length, as I was at a loss to know

on what line to proceed. As the symptoms presented were very much like those in lumbar Pott's disease, it seemed to me best to quiet any irritation which might exist there, and this I did by the plaster-of-Paris jacket, as it offered the most perfect fixation.

I gave, however, a very guarded prognosis, thinking that permanent disability would result, and I was very much surprised at the good recovery on fixation and the disappearance of notable disability, although the characteristic deformity was but little diminished.

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Hertzfeld. Woman, aged twenty-five years; fall in sixth year. *Allg. med. Zeit.*, 1892, xxxvii.

Lane, woman, aged thirty-five years; associated with progressive paraplegia. Laminectomy for relief of pressure of cauda equina. *Lancet*, 1893, xxix. p. 991; also April, 1892, No. 358.

Recamier. Man; between fourth and fifth lumbar vertebræ as a result of spondylolysis; found in dissecting-room. *Bull. de la Soc. d'anat.*, 1888, p. 914.

Braun von Fernwald. One case, woman, aged thirty-six years; occurred under hard work. The most carefully recorded and illustrated of any case. *Archiv f. Gyn.*, 1896, lii. p. 8.

Schleiser. Ein Fall von S. Becken. Inaugural Dissertation, Halle, 1890. There is said to have been a case reported by Herff. v. Braun, *Cent. f. Gyn.*, 1891, xxviii. 603. No details. Woman.

Bohn. Woman, aged twenty-five years; fall when twenty-one years old. Inaugural Dissertation, Berlin, 1892.

Piskadek. Woman, aged thirty-nine years; probably ossification defect in fifth lumbar vertebra. *Cent. f. Gyn.*, 1889, xlviii. p. 83.

Dollinger. Child, three years old, who fell backward in a room, and paralysis came on. Lordosis was marked, apparently, but the column could be felt to have fallen forward from the sacrum, and could be pushed forward. *Cent. f. Chir.*, 1891, xxiii. p. 457.

Bennett. Two preparations. *Lancet*, July 20, 1889, p. 116.

Frank. Woman; no details. *Cent. f. Gyn.*, 1892, xviii. p. 343.

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